Lloyd's Register

Rules and Regulations for the Classification of Inland Waterways Ships, November 2008

Notice No. 4

Effective Date of Latest Amendments:

See page 1

Issue date: February 2010

RULES AND REGULATIONS FOR THE CLASSIFICATION OF INLAND WATERWAYS SHIPS,

November 2008

Notice No. 4

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Inland Waterways Ships, November 2008.* The amendments are effective on the dates shown:

Part	***Chapter***	***Section***	***Effective date***
5	1	2, 3, 4, 5, 6	1 July 2010
5	2	1, 2, 3	1 July 2010
5	3	4	1 July 2010
5	4	2, 3	1 July 2010
5	5	3	Corrigendum
5	6	2, 5	1 July 2010
5	8	1	1 July 2010
5	9	1	1 July 2010
5	10	1, 2, 5, 9	1 July 2010
5	10	5, 8	Corrigenda
5	11	1, 2, 3, 6, 8, 10	1 July 2010
5	12	2, 3, 4, 11	1 July 2010
5	12	2, 10, 11	Corrigenda
5	13	1, 2, 3, 4, 5, 6, 7, 8	1 July 2010
5	13	1, 3, 9	Corrigenda
5	14	Whole Chapter	1 July 2010
5	15	3	1 July 2010
5	15	1, 2	Corrigenda
5	16	2	1 July 2010
5	16	3	Corrigendum
5	17	1, 2	1 July 2010

The *Rules for Inland Waterways* are to be read in conjunction with this Notice No. 4.
The status of the Rules is now:

Rules for Inland Waterways	Effective date:	November 2008
Notice No. 1	Effective date:	1 March 2009
Notice No. 2	Effective date:	1 April 2009
Notice No. 3	Effective date:	1 July 2010 and Corrigendum
Notice No. 4	Effective date:	1 July 2010 and Corrigenda

Part 5, Chapter 1
General Requirements for the Design and Construction of Machinery

Effective date 1 July 2010

■ *Section 2*
Plans and particulars

2.3 Welding

2.3.1 Welding consumables, plant and equipment are to be in accordance with the requirements specified in Ch 13,1.8 of the Rules for Materials.

2.3.2 Welding procedures and welder qualifications are to be tested and qualified in accordance with the requirements specified in Chapter 12 of the Rules for Materials.

2.3.3 Production weld tests are to be carried out where specified in the subsequent Chapters of these Rules.

2.3.4 All finished welds are to be subjected to non-destructive examination in accordance with the requirements specified in Ch 13,2.12 of the Rules for Materials and or the requirements specified in the subsequent Chapters of these Rules.

■ *Section 3*
Operating conditions

3.4 Definitions

3.4.1 Main propulsion engines are defined as those which drive main propelling machinery directly or indirectly through mechanical shafting and which may also drive electrical generators to provide power for auxiliary services. Auxiliary engines are defined as those coupled to electrical generators which provide power for auxiliary services, for electrical main propulsion motors or a combination of both.

~~*3.4.1*~~ *3.4.2* Units and formulae included in the Rules, are shown in SI units.

~~*3.4.2*~~ *3.4.3* Pressure gauges may be calibrated in bar, where

1 bar = 0,1 N/mm^2 = 1,02 kgf/cm^2

■ *Section 4*
Machinery room arrangements

4.3 Ventilation

4.3.2 Machinery spaces shall be sufficiently ventilated so as to ensure that when machinery or boilers therein are operating at full power in all weather conditions, a sufficient supply of air is maintained to the spaces for the operation of the machinery.

~~*4.3.2*~~ *4.3.3* The ventilation of a closed engine room on board of tankers is to be arranged such that with an ambient temperature of 20°C the average temperature of the engine room will not exceed 40°C.

4.3.4 The supply of air for the main propulsion engine(s) may not been taken from spaces protected by a fixed fire-extinguishing installation. This requirement is not applicable if two independent gastight separated machinery rooms are available or if next to the machinery room a steerable bow thruster installation is available in a separate engine room capable of propelling the ship in case of a main machinery room fire. Plans of the independent steerable bow thrust installation are to be submitted for consideration in such cases, *see* Chapter 17.

4.5 Means of escape

4.5.1 ~~For means of escape from machinery spaces, *see* Pt 3, Ch 6,7.1 and Pt 6, Ch 3,8.1.5.~~ In machinery spaces two means of escape are generally to be provided, *see* Pt 3, Ch 6,7.1.

■ *Section 5*
Propulsion redundancy

5.1 Shaft system and bow thruster

5.1.2 Passenger ships shall be fitted with:

- A second independent propulsion system capable of propelling the ship by malfunctioning of the main propulsion system.
- The second independent system is to be installed in a separate machinery space, if both machinery spaces have a common boundary it is to be insulated to A60 Standard.

■ *Section 6*
Trials

6.2 Trials

6.2.5 The following information is to be available on board for the use of the Master and designated personnel:

- The results of trials to determine stopping times, ship headings and distance;
- For ships having multiple propellers, the results of trials to determine the ability to navigate and manoeuvre with one or more propellers inoperative.

~~*6.2.5*~~ *6.2.6* Where the ship is provided with supplementary means for manoeuvring or stopping, such as a bow thruster, the effectiveness of such means are to be demonstrated.

6.2.7 The stopping distance achieved when the ship is initially proceeding ahead with a speed of 13 km/h in running water (running velocity 1,5 m/s) should be as follows:

(a) 550 m for ships having a length $L > 110$ m or breath $B > 14{,}5$ m, or

(b) 480 m for ships having a length $L \leq 110$ m or breath $B \leq 11{,}45$ m

The stopping distance achieved when the ship is initially proceeding ahead with a speed of 13 km/h in water having a running velocity of less than 0,2 m/s should be as follows:

(c) 350 m for ships having a length $L > 110$ m or breath $B > 14{,}5$ m, or

(d) 305 m for ships having a length $L \leq 110$ m or breath $B \leq 11{,}45$ m.

~~*6.2.6*~~ *6.2.8* All trials are to be to the Surveyor's satisfaction.

Part 5, Chapter 2
Oil Engines

Effective date 1 July 2010

■ *Section 1*
Plans and particulars

1.1 Plans

1.1.1 The following plans and particulars as applicable are to be submitted for consideration:

- Crankshaft assembly plan (for each crank-throw).
- Crankshaft details plan (for each crank-throw).
- Thrust shaft shaft or intermediate shaft (if integral with engine).
- ~~Thrust bearing assembly.~~
- ~~Coupling~~ Output shaft coupling bolts.
- ~~Counterweights, where attached to crankthrow.~~
- Main engine ~~holding down~~ securing arrangements where non-metallic chocks are used ~~arrangement~~.
- Type and arrangement of crankcase explosion relief valves.
- Arrangement and welding specifications with details of the procedures for fabricated bedplate, thrust bearing bedplate, crankcases, frames and entablatures. Details of materials welding consumables, fit-up conditions fabrication sequence and heat treatments are to be included.
- Schematic layouts of the following systems, *see also* 1.1.4:
  - Starting air.
  - Fuel oil.
  - Lubricating oil.
  - Cooling water.
  - Control and safety.
  - Hydraulic oil (for valve unit).
- Shielding of high pressure fuel pipes.
- Combustion pressure-displacement relationship.
- Crankshaft design data as outlined in Section 3.
- High pressure parts of fuel oil injection system with specification of pressures dimensions and materials.

1.1.2 The following plans are to be submitted for information:

- Longitudinal and transverse cross-section.
- Cast bedplate, thrust bearing bedplate, crankcase and frames.
- Cylinder ~~cover, liner and jacket (or engine block)~~ head assembly.
- Cylinder liner.
- Piston assembly.
- Tie rod.
- Connecting rod, piston rod, and crosshead assemblies.
- Camshaft drive and camshaft general arrangement.
- Shielding and insulation of exhaust pipes.
- Details of turbo-chargers, *see* Section 10.
- Operation and service manuals.
- Vibration dampers/detuners and moment compensators.
- Thrust bearing assembly (if integral with engine and not integrated in the bedplate).
- Counterweights, where attached to crank-throw, including fastening.
- Main engine holding down arrangement (metal chocks).

1.1.4 Where engines incorporate electronic control systems, a failure mode and effects analysis (FMEA) is to be submitted to demonstrate that failure of an electronic control system will not result in the loss of essential services for the operation of the engine and that operation of the engine will not be lost or degraded beyond an acceptable performance criteria of the engine. This is concerned with the functioning of the control system and not failure of the software itself.

Existing paragraphs 1.1.4 *and* 1.1.5 *have been renumbered* 1.1.5 *and* 1.1.6.

Part 5, Chapters 2 & 3

■ *Section 2*
Materials

2.2 Material test and inspections

Table 2.2.1 Test requirements for oil engine components (*Part only shown*)

NOTES
1. For closed-die forged crankshafts, the ultrasonic examination may be confined to the initial production and to subsequent occasional checks.
2. Cylinder covers and liners manufactured from spheroidal or nodular graphite iron castings may not be suitable for ultrasonic NDE, depending upon the grain size and geometry. An alternative NDE procedure is to be agreed with LR.
3. Bore dimensions refer to engine cylinder bores.
4. All required material tests are to be witnessed by the Surveyor unless alternative arrangements have been specifically agreed by LR.

■ *Section 3*
Design

3.2 Information to be submitted

(*Part only shown*)

3.2.1 In addition to detailed dimensioned plans, the following information is required to be submitted:

- Mass of piston (including piston rod and crosshead where applicable), in kg.
- All individual reciprocating masses acting on one crank, in kg.
- Material specification(s).

3.3 Symbols

(*Part only shown*)

3.3.1 For the purposes of this Chapter, the following symbols apply (*see also* Fig. 2.3.2):

D_{pi}, D_{ji} = internal diameter of pin or main journal, in mm
d_o = diameter of radial oil bore in crankpin, in mm
F = alternating force at the web centre line, in N

M_b = alternating bending moment at web centre line, in N-mm (NOTE: alternating is taken to be $^1/_2$ range value)
M_{BON} = alternating bending moment calculated at the outlet of crankpin oilbore
M_p, M_j = undercut of fillet radius into web measured from web face, in mm

β_T = torsional stress concentration factor for main journal
γ_B = bending stress concentration factor for radially drilled oil hole in the crankpin
γ_T = torsional stress concentration factor for radially drilled oil hole in the crankpin
σ_{ax} = alternating axial stress, in N/mm^2

Part 5, Chapter 3
Gearing

Effective date 1 July 2010

■ *Section 4*
Construction

4.3 Gearcases

~~*4.3.3* The welding is to be carried out in positions free from draughts and is to be downhand (flat) wherever practicable. Welding consumables are to be suitable for the materials being joined.~~

Existing paragraphs 4.3.4 *to* 4.3.6 *have been renumbered* 4.3.3 *to* 4.3.5.

Part 5, Chapter 4
Main Propulsion Shafting

Effective date 1 July 2010

■ *Section 2*
Materials

2.1 Materials for shafts

~~*2.1.3*~~ *2.1.2* Where it is proposed to use alloy steel, details of the chemical composition, heat treatment and mechanical properties are to be submitted for approval.

2.1.3 Where shafts may experience vibratory stresses close to the permissible stresses for transient operation, the materials are to have a specified minimum tensile strength of 500 N/mm^2 .

~~*2.1.2*~~ *2.1.4* Where materials with greater specific or actual tensile strengths than the limitations given above are used, reduced shaft dimensions or higher permissible vibration stresses are not acceptable when derived from the formulae used in Section 3.2, 3.4, 3.5 and Ch 6,2.5.

■ *Section 3*
Design

3.2 Intermediate shafts

3.2.1 The diameter, *d*, of the intermediate shaft is to be not less than determined by the following formula:

$$d = F k \sqrt[3]{\frac{P}{R}\left(\frac{560}{\sigma_u + 160}\right)} \quad \text{mm}$$

k = 1,0 for shafts with integral coupling flanges complying with 3.7 or with shrink fit couplings, *see* 3.2.2

k = 1,10 for shafts with keyways in tapered or cylindrical connections where the fillet radii in the transverse section of the bottom of the keyway are to be not less than 0,0125*d*

F = 89 for electric propulsion installations

F = 94 for diesel engine installations

P and *R* are defined in Ch 1,3.3 (losses in gearboxes and bearings are to be disregarded)

σ_u = specified minimum tensile strength of the material, in N/mm^2, *see* 2.1.3

After a length of 0,2*d* from the end of a keyway the diameter of the shaft may be gradually reduced to that determined with *k*=1,0.

3.2.2 For shrink fit couplings *k* refers to the plain shaft section only. Where shafts may experience vibratory stresses close to the permissible stresses for continuous operation, an increase in diameter to the shrink fit diameter is to be provided, e.g. a diameter increase of 1 to 2 per cent and a blending radius as described in 3.8.

3.2.3 Keyways are in general not to be used in installations with a barred speed range.

Existing paragraphs 3.2.2 and 3.2.3 have been renumbered 3.2.4 and 3.2.5.

3.3 Thrust shafts external to engines

3.4 Screw shafts and tube shafts

3.4.2 The diameter, d_p of the protected screw shaft immediately forward of the forward face of the propeller boss or, if applicable, the forward face of the screw shaft flange, is to be not less than determined by the following formula:

$$d = 94k \sqrt[3]{\frac{P}{R}\left(\frac{560}{\sigma_u + 160}\right)} \quad \text{mm}$$

where

k = 1,22 for a shaft carrying a keyless propeller fitted on a taper, or where the propeller is attached to an integral flange, and where the shaft is oil lubricated and provided with an approved type of oil sealing gland

= 1,26 for a shaft carrying a keyed propeller and where the shaft is oil lubricated and provided with an approved type of oil sealing gland

P and *R* are defined in Ch 1,3.3 (losses in gearboxes and bearings are to be disregarded)

σ_u = specified minimum tensile strength of the shaft material, in N/mm^2 but is not to be taken as greater than 600 N/mm^2. *See* 2.1.3.

3.7 Couplings and transitions of diameters

3.7.1 The minimum thicknesses of the coupling flanges are to be equal to the diameters of the coupling bolts at the face of the couplings as required by ~~3.8~~ 3.8.1, and for this purpose the minimum tensile strength of the bolts is to be taken as equivalent to that of the shafts. For intermediate shafts, thrust shafts and the inboard end of the screwshaft, the thickness of the coupling flange is in no case to be less than 0,20 of the diameter of the intermediate shaft as required by 3.2.

3.8 Coupling bolts

3.8.2 Where dowels or expansion bolts are fitted to transmit torque in shear they are to comply with the requirements of 3.8.1. The expansion bolts are to be installed, and the bolt holes in the flanges are to be correctly aligned in accordance with manufacturer's instructions.

(*Part onl shown*)

~~*3.8.2*~~ *3.8.3* The minimum diameter of tap bolts or of bolts in clearance holes at the joining faces of coupling flanges, pretensioned to 70 per cent of the bolt material yield strength value, is not to be less than:

Q = external load on bolt in N (+ve tensile load tending to separate flange, –ve)

~~3.8.3~~ *3.8.4* Consideration will be given to those arrangements where the bolts are pre-tensioned to loads other than 70 per cent of the material yield strength.

3.8.5 Where clamp bolts are fitted they are to comply with the requirements of 3.8.2 and are to be installed, and the bolt holes in the flanges correctly aligned, in accordance with manufacturer's instructions.

3.12 Sternbushes and sterntube arrangement

3.12.2 The length of the bearing in the sternbush next to and supporting the propeller is to be as follows:

(a) For water lubricated bearings which are lined with rubber composition or staves of approved plastics material, the length is to be not less than four times the diameter required for the screwshaft under the liner.

(b) For water lubricated bearings lined with two or more circumferentially spaced sectors or an approved plastics material, in which it can be shown that the sectors operate on hydrodynamic principles, the length of the bearing is to be such that the nominal bearing pressure will not exceed 0,55 N/mm^2 ~~(5,6 kgf/mm^2)~~. The length of the bearing is to be not less than twice its diameter.

(c) For oil lubricated bearings of synthetic material the flow of lubricant is to be such that overheating, under normal operating conditions, cannot occur. The acceptable nominal bearing pressure will be considered upon application and is to be supported by the results of an agreed test programme. In general, the length of the bearing is not to be less than 2,0 times the rule diameter of the shaft in way of the bearing.

~~(c)~~ (d) For bearings which are white-metal lined, oil lubricated and provided with an approved type of oil sealing gland, the length of the bearing is to be approximately twice the diameter required for the screwshaft and is to be such that the nominal bearing pressure will not exceed 0,8 N/mm^2 ~~(8,1 kgf/cm^2)~~. The length of the bearing is to be not less than 1,5 times its diameter.

~~(d)~~ (e) For bearings of cast iron and bronze which are oil lubricated and fitted with an approved oil sealing gland, the length of the bearing is, in general, to be not less than four times the diameter required for the screwshaft.

~~(e)~~ (f) For bearings which are grease lubricated, the length of the bearing is to be not less than four times the diameter required for the screwshaft.

~~(f) Oil lubricated non-metallic bearings are to be manufactured from an approved material. The length of the bearing is to be such that the maximum approved bearing pressure is not exceeded for any limiting length to diameter ratio.~~

3.12.6 Bearings of synthetic material are to be supplied finished machined to design dimensions within a rigid bush. Means are to be provided to prevent rotation of the lining within the bush during operation.

Existing paragraphs 3.12.6 *to* 3.12.10 *have been renumbered* 3.12.7 *to* 3.12.11.

Part 5, Chapter 5

Propellers

CORRIGENDUM

■ *Section 3*

Design

3.1 Minimum blade thickness

3.1.2 The fillet radius between the root of a blade and the boss of a propeller is to be not less than the Rule thickness of the blade or equivalent at this location. Composite radiused fillets or elliptical fillets which provide a greater effective radius to the blade are acceptable and are to be preferred. Where fillet radii of the required size cannot be provided, the value of U is to be multiplied by $\left(\frac{r}{R}\right)^{\sim\!\!2\ 0,2}$

where

r = proposed fillet radius at the root, in mm

T = Rule thickness of the blade at the root, in mm

Where a propeller has bolted-on blades, consideration is also to be given to the distribution of stress in the palms of the blades. In particular, the fillets of recessed bolt holes and the lands between bolt holes are not to induce stresses which exceed those permitted at the outer end of the fillet radius between the blade and the palm.

Part 5, Chapter 6
Shaft Vibration and Alignment

Effective date 1 July 2010

■ *Section 2*
Torsional vibration

2.11 Restricted speed and/or power ranges

2.11.1 Restricted speed and/or power ranges will be imposed to cover all speeds where the stresses exceed the limiting values, τ_C, for continuous running, including one-cylinder misfiring conditions if intended to be continuously operated under such conditions. For controllable pitch propellers with the possibility of individual pitch and speed control, both full and zero pitch conditions are to be considered. Similar restrictions will be imposed, or other protective measures required to be taken, where vibratory torques or amplitudes are considered to be excessive for particular machinery items. At each end of the restricted speed range the engine is to be stable in operation.

2.11.2 The restricted speed range is to take account of the tachometer speed tolerances at the barred speeds.

~~*2.11.2*~~ *2.11.3* Critical responses which give rise to speed restrictions are to be arranged sufficiently removed from the maximum revolutions per minute to ensure that, in general, at $r = 0{,}8$ the stress due to the upper flank does not exceed τ_C.

~~*2.11.3*~~ *2.11.4* ~~Where shafting stresses due to a torsional critical response exceed the limiting values, τ_e, for continuous running, the speed restriction will be from:~~ Provided that the stress amplitudes due to a torsional critical response at the borders of the barred speed range are less than τ_C under normal and stable operating conditions the speed restriction derived from the following formula may be applied:

$$\frac{16}{18-r} N_C \text{ to } \frac{18-r}{16} N_C \text{ inclusive.}$$

Existing paragraphs 2.11.4 *to* 2.11.9 *have been renubered* 2.11.5 *to* 2.11.10.

2.11.11 Restricted speed ranges in one-cylinder misfiring conditions on ships with single engine propulsion are to enable safe navigation whereby sufficient propulsion power is available to maintain control of the ship.

2.11.12 There are to be no restricted speed ranges imposed above a speed ratio of $r = 0{,}8$ under normal operating conditions.

■ *Section 5*
Shaft alignment

5.1 General

~~*5.1.1* The Builder is to carry out shaft alignment calculations for all installations and to prepare alignment procedures detailing the proposed alignment method and the alignment checks.~~

5.1.1 Shaft alignment calculations are to be carried out for main propulsion shafting rotating at propeller speed, including the final reduction gear wheel on geared installations. The Builder is to make available shaft alignment procedures detailing the proposed alignment method and checks for these arrangements.

5.2 Particulars to be submitted for approval – shaft alignment calculations

5.2.1 Shaft alignment calculations are to be submitted to LR for approval for the following shafting systems ~~where the screwshaft has a diameter of 300 mm or greater in way of the aftermost sterntube bearing~~:

(a) all geared installations, where the screwshaft has a diameter of 300 mm or greater in way of the aftmost bearing;

~~(b) installations with one shaftline bearing, or less, inboard of the forward sterntube bearing/seal;~~

~~(c)~~ (b) where prime movers or shaftline bearings are installed on resilient mountings.

5.2.2 The shaft alignment calculations are to take into account the:

(a) thermal displacements of the bearings between cold static and hot dynamic machinery conditions;

(b) buoyancy effect of the propeller immersion due to the ship's operating draughts;

(c) effect of predicted hull deformations over the range of the ship's operating draughts, where known;

(d) effect of filling the aft peak ballast tank upon the bearing loads, where known;

~~(d)~~ (e) gear forces, where appropriate, due to prime-mover engagement on multiple-input single-output installations;

~~(e) for multi-engined installations, possible contributions in the mode of operation;~~

(f) propeller offset thrust effects~~, where applicable~~;

~~(g) bearing loading in the horizontal plane, where appropriate; and~~

~~(h)~~ (g) maximum allowed bearing weardown, ~~where applicable~~ for water or grease-lubricated sterntube bearings, and its effect on the bearing loads.

5.2.3 The shaft alignment calculations are to state the:

(a) expected bearing loads at light and normal ballast, fully loaded and any other draughts deemed to be part of the ship's operating profile, for the machinery in cold and hot, static and dynamic conditions;

(b) bearing influence coefficients and the deflection, slope, bending moment and shear force along the shaftline;

(c) details of propeller offset thrust~~ effects, where employed in calculation~~;

(d) details of proposed slope-bore of the aftermost sterntube bearing, where applicable;

(e) manufacturer's specified limits for bending moment and shear force at the shaft couplings of the gearbox/prime movers;

(f) estimated bearing weardown rates for water or grease-lubricated sterntube bearings;

(g) ~~origin of findings where the effect of~~ expected hull deformation effects and their origin ~~has been considered~~, *viz*. whether finite element calculations or measured results from sister or similar ships have been used;
(h) anticipated thermal rise of prime movers and gearing units between cold static and hot running conditions; and
(j) manufacturer's allowable bearing loads.

5.3 ~~Particulars to be submitted for review – Shaft alignment procedure~~ Shaft alignment procedures

5.3.1 A shaft alignment procedure is to be ~~submitted~~ made available for review and for the information of the attending Surveyors for all main propulsion installations detailing, as a minimum~~, the~~:
(a) expected bearing loads at light and normal ballast, fully loaded and any other draughts deemed to be part of the ship's operating profile, for the machinery in cold and hot, static and dynamic conditions;
(b) maximum permissible loads for the proposed bearing designs;
(c) design bearing offsets from the straight line;
(d) design gaps and sags;
(e) location and loads for the temporary shaft supports;
(f) expected relative slope of the shaft and the bearing in the aftermost sterntube bearing;
(g) details of slope-bore of the aftermost sterntube bearing, where applied;
~~(h) expected shear forces and bending moments at the forward end flange of the shafting system connecting to the gear output shaft or, for direct drive installations, to the prime mover output flange;~~
~~(i)~~ (h) proposed bearing load measurement technique and its estimated accuracy;
~~(k)~~ (j) jack correction factors for each bearing where the bearing load is measured using a specified jacking technique;
~~(l)~~ (k) proposed shaft alignment acceptance criteria, including the tolerances; and
~~(m)~~ (l) flexible coupling alignment criteria.

5.4 Design and installation criteria

5.4.2 Design and installation of the shafting is to satisfy the following criteria:
(a) The Builder is to position the bearings and construct the bearing seatings to minimize the effects of hull deflections under any of the ship's operating conditions with the aim of optimising the bearing load distribution.
(b) Relative slope between the propeller shaft and the aftermost sterntube bearing is, in general, not to exceed 3×10^{-4} rad.
(c) Sterntube bearing loads are to satisfy the requirements of Ch 4,3.12.
(d) Evidence is to be provided to LR demonstrating that bearings of synthetic material have been verified as being within the tolerance stated by the bearing manufacturer for diameter, ovality, and straightness after installation.
(e) Bearings of synthetic material are to be verified as being within tolerance for ovalilty and straightness, circumferentially and longitudinally, after installation.
(f) The sterntube forward bearing static load is to be sufficient to prevent unloading in all static and dynamic operating conditions, including the transient conditions experienced during manoeuvring turns.
~~(d)~~ (g) Intermediate shaft bearings' loads are not to exceed 80 per cent of the bearing manufacturer's allowable maximum load, for plain journal bearings, based on the bearing projected area.
~~(e)~~ (h) ~~Main gear wheel~~ Equipment manufacturer's bearing loads are to be within the ~~gearbox~~ manufacturer's specified limits, i.e. prime movers, gearing.
~~(f)~~ (j) Resulting shear forces and bending moments are to meet the equipment manufacturer's specified coupling conditions ~~throughout the shafting system~~.
~~(g)~~ (k) The manufacturer's radial, axial and angular alignment limits for the flexible couplings are to be maintained.

5.5 Measurements

5.5.1 The system bearing load measurements are to be carried out to verify that the design loads have been achieved. In general the measurements will be carried out by the jack-up measurement technique using calibrated equipment.

5.5.2 For the first vessel of a new design an agreed programme of static shaft alignment measurements is to be carried out in order to verify that the shafting has been installed in accordance with the design assumptions and to verify the design assumptions in respect of the hull deflections and the effects of machinery temperature changes. The programme is to include static bearing load measurements in a number of selected conditions. Depending on the ship type and the operational loading conditions that are achievable prior to and during sea trials these should include, where practicable, combinations of light ballast cold, full ballast cold, full ballast hot and full draught hot with aft peak tank empty and full.

5.5.3 For vessels of an existing design or similar to an existing design where evidence of satisfactory service experience is submitted for consideration and for subsequent ships in a series a reduced set of measurements may be accepted. In such cases the minimum set of measurements is to be sufficient to verify that the shafting has been installed in accordance with the design assumptions and are to include at least one cold and one hot representative condition.

~~*5.5.1*~~ *5.5.4* Where calculations indicate that the system is sensitive to changes in alignment under different service conditions, the ~~optimized~~ shaft alignment is to be verified by measurements during ~~sea~~ trials using an approved strain gauge technique.

Part 5, Chapter 8
Fired Boilers

Effective date 1 July 2010

■ *Section 1*
General requirements

1.1 Application

1.1.2 The scantlings of coil type heaters with pumped circulation, which are fired or heated by exhaust gas are to comply with the appropriate requirements of ~~this Chapter~~ Pt 5, Ch 10 the Rules and Regulations for the Classification of Ships (hereinafter referred to as the Rules for Ships).

1.2 Plans

1.2.3 Boiler Manufacturers are referred to in ~~Pt 5, Ch 10 of the *Rules and Regulations for the Classification of Ships*~~ Pt 5, Ch 10 of the Rules for Ships, which contain detailed requirements for the materials, the manufacture and testing of boilers.

Part 5, Chapter 9
Pressure Vessels other than Boilers

Effective date 1 July 2010

■ *Section 1*
General requirements

1.5 Classification of fusion welded pressure vessels

1.5.7 ~~Heat treatment, non-destructive and routine tests where required, for the four Classes of fusion welded pressure vessel are indicated in Table 9.1.1. Details of these requirements are given in Chapter 14.~~ Details of heat treatment, non-destructive examination and routine tests (where required) are given in Chapter 13 of the Rules for Materials.

1.5.8 Hydraulic testing is required for all Classes of pressure vessels.

~~Table 9.1.1 Heat treatment, non-destructive examination and testing requirements~~

Class	Radiographic examination	Heat treatment	Routine weld tests	Hydraulic test
1	Required, *see* Chapter 14	*see* Chapter 14	Required	Required
2/1	Spot required, *see* Chapter 14	*see* Chapter 14	Required	Required
2/2	—	*see* Chapter 14	Required	Required
3	—	—	—	Required

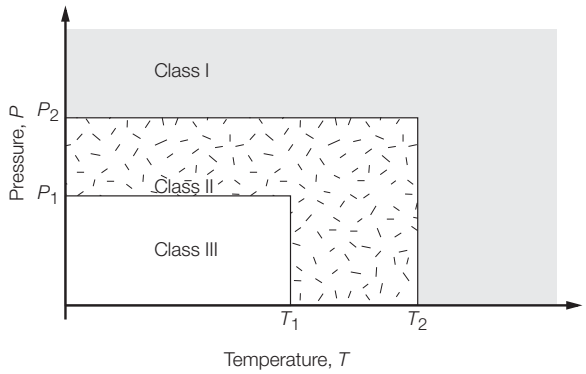
Part 5, Chapter 10
Piping Design Requirements

Effective date 1 July 2010

■ *Section 1*
General

1.5 Classes of pipes

1.5.2 Dependent on the service for which they are intended, Class II and III pipes are not to be used for design pressure or temperature conditions in excess of those shown in Table 10.1.1. Where either the maximum design pressure or temperature exceeds that applicable to Class II pipes, Class I pipes are to be used~~, *see* 1.1.2~~. To illustrate this, *see* Fig. 10.1.1. *See also* 1.1.2 for temperatures exceeding 300°.



NOTE
T_1 and P_1 correspond to the maximum temperatures and pressures for a Class III piping system and T_2 and P_2 to those for a Class II piping system depending on the service.

Fig. 10.1.1 Classes of piping system

■ *Section 2*
Carbon and low alloy steels

2.2 Wrought steel pipes and bends

(*Part only shown*)

Table 10.2.3 Minimum thickness for steel pipes

NOTES
4. For air and sounding pipes, the minimum thickness applies to the part of the pipe outside the tank but not exposed to the weather. The section of pipe exposed to the weather is required to be suitably increased in thickness or in compliance with the requirements of the relevant Authorities.
~~5. Sounding pipes for cargo tanks, having a flash point of less than 55°C, the minimum thickness is also applicable for the part inside the tank.~~

2.5 Welded-on flanges, butt welded joints and fabricated branch pieces

2.5.3 Butt welded joints are ~~to meet~~ generally to be of the full penetration type and are to meet the requirements of ~~Chapter 14~~ Chapter 13 of the Rules for Materials.

2.7 Socket weld joints

2.7.2 The thickness of the socket weld fittings is to meet the requirements of 2.2.4 but is to be not less than 1,25 times the nominal thickness of the pipe or tube. The diametral clearance between the outside diameter of the pipe and the bore of the fitting is not to exceed 0,8 mm, and a gap of approximately 1,5 mm is to be provided between the end of the pipe and the bottom of the socket. *See also* ~~Ch 14,6.2.3~~ Ch 13,5.2.9 of the Rules for Materials.

2.12 Non-destructive testing

2.12.1 For details of non-destructive tests on piping systems, other than hydraulic tests, *see* ~~Chapter 14~~ Chapter 13 of the Rules for Materials.

■ *Section 5*
Plastics pipes

CORRIGENDA

5.4 Fire performance criteria

Table 10.5.3 Fire endurance requirements
(*see continuation*) (*Part only shown*)

Rule between item 2 and 3 has been deleted.

2 Crude oil washing lines	N/A	. . .
3 Vent lines	N/A	. . .
INERT GAS		
11 Hydraulic oil	X	. . .
OUTBOARD WATER[1]		

Effective date 1 July 2010

5.7 Installation and construction

5.7.8 Where piping systems are arranged to pass through watertight bulkheads or decks, provision is to be made for maintaining the integrity of the bulkhead or deck by means of metallic bulkhead, or deck pieces. The bulkhead pieces are to be of substantial construction and suitably protected against corrosion and so constructed to be of a strength equivalent to the intact bulkhead; attention is drawn to 5.7.1, *see also* Pt 5, Ch 11,2.4.1. Details of the arrangements are to be submitted for approval. ~~*See also* Pt 6, Ch 3,9.~~

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■ *Section 8* Flexible hoses

8.1 ~~F~~General

Effective date 1 July 2010

■ *Section 9* Hydraulic tests on pipes and fittings

9.1 Hydraulic tests before installation on board

9.1.3 Where testing of systems or sub-systems following final assembly is specified, in addition to the requirements of 9.1.2 the lowest applicable pressure as defined in this sub-Section is to be used for testing.

~~*9.1.3* All valve bodies are to be tested by hydraulic pressure to 1,5 times the nominal pressure rating at ambient temperature.~~

9.1.4 Valves and fittings non-integral with the piping system, intended for Classes I and II, are to be tested in accordance with Recognised Standards, but to not less than 1,5 times the design pressure. Where design features are such that modifications to the test requirements are necessary, alternative proposals for hydraulic tests are to be submitted for special consideration.

~~*9.1.4*~~ *9.1.5* All valves are to be tested for tightness at 1,1 times the maximum permissible working pressure.

9.1.6 For requirements relating to valves and cocks intended to be fitted on the ship's side below the load water line, *see* Ch 11,2.5.7.

9.1.7 In no case is the membrane stress to exceed 90 per cent of the yield stress at the testing temperature.

Part 5, Chapter 11
Ship Piping Systems

Effective date 1 July 2010

■ *Section 1* General requirements

1.3 Plans and particulars

1.3.1 The following plans (in diagrammatic form) and particulars are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of a novel or special character affecting classification:

- (a) Arrangements of air pipes and closing devices for all tanks and enclosed spaces.
- (b) Sounding arrangements for all tanks, enclosed spaces and cargo holds.
- (c) Arrangements of level alarms fitted in tanks, cargo holds, machinery spaces, pump rooms and any other spaces.
- (d) Arrangements of any cross flooding or healing tank systems.
- (e) Bilge drainage arrangements for all compartments which are to include details of location, number and capacity of pumping units on bilge service.
- (f) Ballast filling and drainage arrangements.
- (g) Oil fuel ~~pumping~~ filling, transfer, relief and spill/drainage arrangements.

(h) Tank overflow arrangements.

- (j) Arrangements for flooding holds together with blanking arrangements for bilge and ballast piping systems for bulk carriers having floodable holds intended for the carriage of dangerous goods.

(k) Bilge systems for bulk carriers where the cargo holds are intended for the carriage of dangerous goods.

- (l) Details verifying compliance with the sizing of air pipes required by 10.8.
- (m) Arrangements of oil fuel piping in connection with oil burning installations and oil fired galleys.

(n) Arrangements of oil fuel burning units for boilers and thermal fluid heaters.

- (o) Arrangement of boiler feed system.

(p) Arrangements of thermal fluid circulation systems.
- (q) Arrangement of compressed air systems for main and auxiliary services.
- (r) Arrangement of lubricating oil systems.
- (s) Arrangements of flammable liquids used for power transmission, control and heating systems.
- (t) Arrangements of cooling water systems for main and auxiliary services.
- (u) Oil fuel tanks not forming part of the ship's structure.
- (v) Arrangements and dimensions of all steam pipes, with details of flanges, bolts and weld attachments, and particulars of the material of pipes, flanges, bolts and electrodes.
- (w) Arrangements and details of box coolers for main and auxiliary services.

(x) Details verifying compliance of demands on low pressure Air systems by essential systems as required by Ch 12,10.

■ *Section 2*
Construction and installation

2.1 Materials

2.1.4 Aluminium alloy pipes are not acceptable for fire extinguishing pipes unless they are suitably protected against the effect of heat. The proposed use of aluminium alloy with appropriate insulation will be considered when it has been demonstrated that the arrangements provide equivalent structural and integrity properties compared to steel. In open and exposed locations where the insulation material is likely to suffer from mechanical damage suitable protection is to be provided.

2.3 Valves – Installation and control

2.3.5 Remotely controls of valves on passenger ships situated above the bulkhead deck are to be clearly indicated.

■ *Section 3*
Drainage of compartments, other than machinery spaces

3.5 Fore and after peaks

3.5.2 Where the peaks are not used as tanks, and main bilge line suctions are not fitted, drainage of both peaks may be effected by hand pump suctions. Drainage of the after peak, for ships, other than passenger ships, may be effected by means of a self-closing cock fitted in a well lighted and readily accessible position.

■ *Section 6*
Pumps on bilge service and their connections

6.1 Number of pumps

6.1.1 In ships, other than passenger ships, with engines up to 220 kW, at least one power bilge pump is to be provided which may be worked from the main engine. In addition, hand pump suctions are to be fitted. In ships with engines exceeding 220 kW, at least two power bilge pumps are to be provided in the machinery space, one of which may be worked from the main engines and the other is to be independently driven.

6.1.2 For ships, other than passenger ships having separate machinery spaces, not connected to a common bilge system and with installed auxiliary engines up to 220 kW, at least one power bilge pump is to be provided which may be worked from the auxiliary engine. In addition, hand pump suctions are to be fitted. For installed auxiliary engines exceeding 220 kW, at least two power bilge pumps are to be provided in the machinery space, one of which may be worked from the auxiliary engines and the other is to be independently driven.

6.2 General service pumps

6.2.1 The bilge pumps required by 6.1, may also be used for ballast, fire or general service duties of an intermittent nature, but they are to be immediately available for bilge duty when required. ~~For use of bilge pumps for fire extinguishing duties, see Pt 6, Ch 3,4.~~

6.2.2 Sanitary, ballast, bilge or general service pumps may be accepted as fire pumps, provided that they are not used for pumping oil fuel.

■ *Section 8*
Additional requirements for bilge drainage of passenger ships

8.2 Prevention of communication between compartments in the event of damage

8.2.2 Open ended pipes and ventilation ducts are to be arranged such that in any condition of flooding water can not enter other watertight compartments:

(a) If several compartments are connected by means of open ended pipe lines or ventilation ducts they are to be arranged such that the open ends are situated above the maximum assumed damage condition.

(b) Pipelines are not required to comply with (a) above if the pipes/ ventilation ducts are provided with shut off valves capable of being operated from above the bulkhead deck.

(c) Pipelines having no open end are to be considered as not damaged if within the extend of damage and the distance from the bottom is more than 0,5 m.

■ *Section 10*
Air and sounding pipes

10.5 Termination of air pipes

10.5.1 Air pipes to double bottom tanks, deep tanks extending to the shell plating, or tanks which can be run up from the waterway are to be led to above the deck. Air pipes to oil fuel and cargo oil tanks, cofferdams and all tanks which can be pumped up are to be led to the open:

(a) For height of air pipes above deck, in general, *see* Pt 3, Ch 11,10.

(b) For height of air pipes above deck for fuel oil tanks on ships carrying dangerous goods or tankers, *see* Pt 4, Ch 1,12.5.3 and Pt 4, Ch 4,3.4.1.

Part 5, Chapter 12
Machinery Piping Systems

Effective date 1 July 2010

■ *Section 2*
Oil fuel – General requirements

2.1 Flash point

2.1.3 Tanks containing oil fuel are to be separated from crew, passenger and baggage compartments by either:

- a gastight steel division additional to the division which retains the oil, or
- a division of all-welded steel construction capable of withstanding a head of water at least 1,5 m greater than the maximum service head.

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2.4 Heating arrangements

2.4.1 Where steam is used for heating oil fuel, cargo oil or lubricating oil, in bunkers, tanks, heaters or separators, the exhaust drains are to discharge the condensate into an observation tank in a well lighted and accessible position where it can be readily seen whether or not it is free from oil, *see* ~~Ch 13,6.4~~ Ch 13,7.4.

2.4.3 For requirements of thermal oil systems as heating medium, *see* Section 11 and ~~Ch 13,6~~ Ch 13,7.

2.4.6 For requirements of heating cargo tanks, *see* ~~Ch 13,6~~ Ch 13,7.

Effective date 1 July 2010

2.7 Oil fuel contamination

2.7.1 The use of copper or zinc compounds in oil fuel distribution and utilisation piping is not permitted except for small diameter pipes in low pressure systems, *see* 4.4.1.

■ *Section 3*
Oil fuel burning arrangements

3.1 Oil burning units

3.1.1 Means are to be provided so that, in the event of flame failure, the oil fuel supply to the burner(s) is shut-off automatically, and an alarm is given, *see* Pt 6, Ch 1,3.3.2.

3.1.2 A warning notice is to be fitted in a prominent position at every oil burning unit local manual control station which specifies that burners operated with manual or local overrides in use are only to be ignited after sufficient purging of the furnace and of any additional precautions required when operating in this condition.

3.1.3 For thermal oil heater arrangements, *see also* 11.4.

~~3.1~~ 3.2 Oil fuel supply to main and auxiliary engines

Existing paragraph 3.1.1 *has been renumbered* 3.2.1.

~~3.2~~ 3.3 Burner arrangements

Existing paragraph 3.2.1 *has been renumbered* 3.3.1.

~~3.3~~ 3.4 Quick-closing valve

Existing paragraph 3.3.1 *has been renumbered* 3.4.1.

■ *Section 4*
Oil fuel pumps, pipes, fittings, tanks, etc.

4.9 Fresh water piping

4.9.1 Pipes in connection with compartments used for storing fresh water are to be separate and distinct from any pipes which may be used for ~~oil or oily water~~ other liquids, and are not to be led through tanks which contain ~~oil,~~ other liquids nor are ~~oil~~ pipes containing other liquids to be led through fresh water tanks.

4.9.2 Fresh water tanks are to be separate and distinct from other tanks carrying flammable or sanitary liquids, *see also* Pt 3, Ch 7,1.6.

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■ *Section 10*
Low pressure compressed air systems

10.5 Pneumatic remote control valves

~~*10.5.6*~~ *10.5.5* The pneumatic pilot pipes running through the machinery space to the relevant control mechanism of the valves are to be of steel.

■ *Section 11*
Thermal oil systems

CORRIGENDUM

11.3 Expansion tank arrangement

11.3.3 Means of approved type are to be provided to ascertain the level in the thermal oil expansion tank.

Effective date 1 July 2010

11.4 Thermal oil heater arrangements

11.4.4 For requirements of oil fuel burning arrangements, *see* Section 3.

Part 5, Chapter 13
Piping Systems for Ships Intended for the Carriage of Liquids in Bulk

Effective date 1 July 2010

■ *Section 1*
General requirements

1.2 Plans and particulars

1.2.1 In addition to the plans and particulars required in Chapter 11, the following plans (in diagrammatic form) are to be submitted for consideration:

- (a) Pumping arrangements at the fore and aft ends, and drainage of cofferdams and pump-rooms.
- (b) General arrangements of cargo piping in tanks and on deck.
- (c) For Type G tankers the maximum vapour pressure and minimum liquid temperature.
- (d) General arrangements of cargo tank vents. The plan is to indicate the type and position of the vent outlets and distance from any superstructure, erection, air intake, etc.
- (e) Arrangements of inert gas piping systems, together with full details of inert gas plant, if fitted. *See* Section 8.
- (f) Details of alarms and safety arrangements required by 1.6. *See also* Pt 6, Ch 1.2.
- (g) Pressure drop calculations, *see* 4.3.
- (h) Cargo heating systems, *see* Section 6.
- (j) Water spray systems, *see* ~~7.2~~ 8.2.

CORRIGENDUM

1.3 Materials

1.3.7 A list of Defined Cargoes, intended to be carried on board, is to be established. Due account is to be given to the materials proposed. *See* Pt 4, Ch 4,1.3 for dangerous liquids. *See* Pt 4, Ch 5,1.5 for Type G tankers and ~~Chapter 6,1.5~~ Pt 4, Ch 6,1.5 for Type C and N tankers.

Effective date 1 July 2010

1.6 Cargo pump-room

1.6.4 Alarms and safety arrangements are to be provided as indicated in ~~1.6.6,~~ 1.6.5 to 1.6.7 and Table 13.1.1. These requirements are applicable to pump rooms where pumps for cargo, such as cargo pumps, stripping pumps, pumps for slop tanks, pumps for COW or similar pumps are provided and not for pump rooms intended solely for ballast transfer. *See also* 1.6.9.

1.6.7 An optic and acoustic alarm is to be provided in the wheelhouse and on deck indicating malfunctioning of the gas detection installation.

1.6.9 Where items of equipment other than described in Table 13.1.1 are located in the pump room and are driven by shafts passing through bulkheads, the potential risk of ignition of hydrocarbon gas is to be assessed and proposals for mitigation submitted to LR for consideration.

Existing paragraph 1.6.9 *has been renumbered* 1.6.10.

Table 13.1.1 Alarms and safety arrangements

Item	Alarm	Note
~~Bulkhead gland temperature~~ Temperature sensing of bulkhead shaft glands, bearings and pump casings	High	~~Any machinery item~~ Cargo, ballast and stripping pumps
~~Bearing temperature~~	~~High~~	~~Any machinery item~~
~~Pump casing temperature~~	~~High~~	~~Cargo pumps only~~
Bilge level	High	
Hydrocarbon concentration	High	> 10% LEL

1.7 Cargo pump-room ventilation

1.7.8 The ventilation ducting is to be arranged to permit extraction from the vicinity of the pump-room bilges. Air intakes are to be so arranged in the upper part of the pump-room to minimize the possibility of recycling hazardous vapour from any ventilation discharge opening. Vent exits are to be arranged to discharge ~~upwards~~ to a safe place on the open deck and comply with the requirements of 1.7.11.

1.9 Bulkhead penetrations

1.9.4 Pipes from the machinery space led to the open, may pass through the pump room/cofferdam/wing tank in the cargo area or a hold space containing the cargo tanks ~~to the open,~~ provided that within ~~the~~ these spaces ~~mentioned above they~~ the pipes are of seamless steel and of substantial wall thickness and have no flanged joints or openings.

1.10 Service spaces in the cargo zone

1.10.1 Other enclosed spaces in the cargo zone not containing cargo handling equipment such as ballast pump rooms, etc., and to which regular access is required, are to be provided with permanent ventilation systems of the mechanical extraction type.

1.10.2 The ventilation system is to be capable of at least 20 air changes per hour, based on the gross volume of the service space.

1.10.3 The ventilation ducting is to be arranged to permit extraction from 50 mm above the bottom of the service space. For the arrangement of air intakes such as height and the required distances to tank hatches and safety valves, *see* Pt 4, Ch 4,3.2.10.

1.10.4 Mechanical ventilation fans are to be of the non-sparking type, *see* 1.8.

1.10.5 Provision is to be made for closing the air intake and extraction ducts in case of fire. The means provided are to be capable of operation from the deck.

1.10.6 For type N-open tankers natural ventilation is acceptable.

■ *Section 2* Piping systems for bilge, ballast, oil fuel, etc.

2.3 Air and sounding pipes

2.3.2 Double bottom tanks and wing tanks in the cargo area intended for ballast purposes are to be provided with an air pipe as per Ch 11,10. Sounding pipes on the cofferdam are to be led to the open deck.

2.3.3 Hold spaces containing independent cargo tanks are to provided with not less that two air pipes. The diameter and position of the air pipes are to be such that each place in the hold will be sufficiently ventilated.

2.3.4 Alternatively the above hold spaces are to be inserted or filled with dry air if air pipes are not provided.

2.3.5 The following tanks and voids in the cargo area are to be ventilated by a suitable appliance:

(a) Double bottom tanks not intended for ballast purposes.
(b) Wing tanks not intended for ballast purposes.
(c) Cofferdams other than mentioned in 2.3.1.
(d) Hold spaces containing independent cargo tanks for Type C and N tankers.

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■ *Section 3* Cargo handling system

3.1 General

3.1.6 Ships carrying toxic products are to be equipped with at least one instrument designed and calibrated for testing for the vapours. For measuring flammable products, *see* ~~4.7~~ 5.7.

Effective date 1 July 2010

3.2 Cargo pumps and compressors

3.2.3 Pump suction and discharge pressure gauges are to be provided at the pumps or compressors except for the suction side of deep well pumps). The pressure gauges ~~and~~ are to be readable at the pump control stations at all times.

3.3 Cargo piping systems

3.3.4 Expansion joints of approved type or bends are to be provided, where necessary, in the cargo pipe lines. Mechanical joints of the slip type may be used only in cargo oil lines. *See also* Ch 11,2.7.2 and Table 10.2.5 in Chapter 10.

3.3.11 The requirements of 3.3.12 to 3.3.17 apply to product and process piping including vapour piping and vent lines of safety valves or similar piping intended for Type G tankers.

3.3.12 All pipelines or components which may be isolated in a liquid full condition should be provided with relief valves.

3.3.13 Consideration will be given to a relaxation of the above requirement for pipe sections with a volume of 50 litres, or less.

3.3.14 Relief valves discharging liquid cargo from the cargo piping system should discharge into the cargo tanks.

3.3.15 The nominal thickness of steel pipes is to be not less than shown in Table 13.3.1 for the appropriate standard pipe size. Stainless steel pipes will receive special consideration.

3.3.16 Flanges, valves and other fittings should comply with Recognised Standards, taking into account the maximum applicable gauge pressure. For bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted.

3.3.17 For flanges not complying with a standard, the dimensions of flanges and related bolts will be specially considered.

Table 13.3.1 Nominal thickness steel pipes

Standard pipe sizes outside diameter, in mm		Minimum over-riding normal thickness in mm
Exceeding	Not exceeding	
—	10,2	1,6
10,2	17,2	1,8
17,2	26,9	2,0
26,9	33,7	2,3
33,7	54,0	2,6
54,0	76,1	2,9
76,1	88,9	3,2
88,9	114,3	3,6
114,3	139,7	4,0
139,7	168,3	4,5
168,3	193,7	5,4
193,7	219,1	5,9
219,1	279,0	6,3
279,0	323,9	7,1
323,9	368,0	8,0
368,0	419,0	8,8

3.4 Terminal fittings at cargo loading stations

3.4.3 For Type G tankers, one remotely operated emergency shutdown valve (quick closing valve) is to be provided in addition to the valve as per 3.4.2. Control of this valve is to be from positions fore and aft of the ship, *see also* 3.7.6.

3.4.7 Shore connections shall be located not less than 6,0 m from entrances to, or openings of, the accommodation and service spaces outside the cargo area. This requirement is not applicable to ships of Type N-open with the exemption when corrosive liquids of Class 8 will be carried.

3.4.8 The distance required by 3.4.7 may be reduced to 3,0 m subject to the requirements of Pt 4, Ch 4,3.3.3.

3.5 Cargo segregation

3.5.2 Blind Flange Valves of an approved type are acceptable as an equivalent means of segregation in cargo systems.

3.5.3 Spectacle Flanges could be accepted in vapour return systems with the exemption for tankers carrying toxic cargoes Class 6.1.

~~*3.5.2*~~ *3.5.4* Cargoes, residues of cargoes or mixtures containing cargoes which react in a hazardous manner with other cargoes, residues or mixtures should:

(a) be segregated from such other cargoes by means of a cofferdam void space, cargo pump room, pump-room, empty tank or tank containing a mutually compatible cargo;
(b) have separate pumping and piping systems which should not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and
(c) have separate tank venting systems.

■ *Section 4* Cargo tanks for Type G tankers

4.4 Design temperature

4.4.1 The design temperatures for the calculations and selection of materials is to be as follows:

- The design temperature, *T*, for calculation purposes is to be not less than 50°C.
- A minimum temperature is to established for the selection of materials, *see* 5.4.1.

~~4.4~~ 4.5 Allowable stresses

Existing paragraphs 4.4.1 *and* 4.4.2 *to be renumbered* 4.5.1 *and* 4.5.2.

~~4.5~~ 4.6 Supports

Existing paragraphs 4.5.1 *to* 4.5.8 *to be renumbered* 4.6.1 *to* 4.6.8.

~~4.6~~ 4.7 Construction and testing

~~*4.6.1*~~ *4.7.1* All welded joints of the shells of independent tank should be of the butt weld, full penetration type.

~~*4.6.2*~~ *4.7.2* ~~Workmanship~~ Manufacture and workmanship ~~is to be to the satisfaction of LR and to the requirements of Chapter 14,2~~ are to satisfy the requirements of Ch 13,1 of the Rules for Materials for Class 1 pressure vessels.

~~*4.6.3*~~ *4.7.3* Independent tanks should be subjected to a hydrostatic test or alternatively to a hydro pneumatic test as per Chapter 4, Section 4.10.10.3 for Type C independent tanks of the Rules for Ships for Liquefied Gases.

~~4.7~~ 4.8 Inspection and non-destructive testing

~~*4.7.1*~~ *4.8.1* For independent tanks, inspection and non-destructive testing should be as far as applicable in compliance with Chapter 4, Section 4.10.9 of the Rules for Ships for Liquefied ~~Gasses~~ Gases and the requirements of Ch 13,4 of the Rules for Materials for Class 1 pressure vessels.

~~4.8~~ 4.9 Corrosion Allowance

Existing paragraph 4.8.1 *to be renumbered* 4.9.1.

4.10 Stress relieving independent tanks

4.10.1 For independent tanks of carbon and carbon-manganese steel, post-weld heat treatment should be performed after welding if the design temperature is below –10°C. The post-weld heat treatment is to conform to the requirements of Table 13.4.2 in Chapter 13 of the Rules for Materials. For all carbon and carbon-manganese steel. Tanks requiring heat treatment, the requirements of Ch 13,1 and Ch 13,4 of the Rules for Materials are to be complied with.

■ *Section 5*
Cargo tank venting arrangements

5.2 Pressure/vacuum and venting systems for various tanker types

(*Part only shown*)

5.2.3 **Type C and N-closed.** Each cargo tank or group of cargo tanks connected to a common vapour pipe is to be provided with:

(h) a pressure gauge on each cargo tank suitable for under and overpressure measurement. The over and under-pressure readings are to be visible at a position were loading or discharging can be stopped or otherwise from a position in the vicinity of the control of the water spray system. The maximum allowable under and over-pressure for the cargo tank is to be indicated on each pressure gauge. The pressure gauges readings are to be visible under all weather conditions.

5.2.4 **Type G.** The requirements of ~~4.2.5 to 4.2.17~~ 5.2.5 to 5.2.18 apply.

5.2.11 The setting of the pressure relief valves is in no case exceeding the maximum design pressure of the independent cargo tanks.

Existing paragraph 5.2.11 *has been renumbered* 5.2.12.

~~*5.2.12*~~ *5.2.13* Each tank is to be provided with a pressure gauge suitable for under and overpressure measurement. The over and under-pressure readings are to be visible at a position were loading or discharging can be stopped. The maximum allowable under and over-pressure for the cargo tank is to be indicated on each pressure gauge. The pressure gauges are to be visible under all weather conditions.

Existing paragraphs 5.2.13 *to* 5.2.18 *have been renumbered* 5.2.14 *to* 5.2.19.

■ *Section 6*
Cargo tank level gauging equipment and arrangements against overfilling

6.1 Sounding devices

6.1.4 Sounding information is to be available at the position where the valves of the cargo tank are controlled.

6.1.5 The maximum allowable filling limit of the cargo tank is to be indicated at each sounding device.

6.1.6 The sounding devices are to be legible under all weather conditions.

6.2 Closed level indicating devices

6.2.1 The cargo tanks of all types of ships~~, except the N-open and N-with flame arrestors,~~ are to be fitted with a ~~closed~~ level indicating device of an approved type. Except for Type N-open and N- with flame arrestors, the level indicating device is to be of the closed type which does not permit the escape of vapour or cargo when being used. For all types of tankers, the device is to be so positioned that it can be easily read from the operating position for the closing valve on the relevant tank.

■ *Section 7*
Cargo heating arrangements

7.4 Heating circuits

~~*7.4.12* The heating system shall not be used during cargo operations. When, however this is unavoidable, the arrangements for electrical equipment, ventilation and gas detection for the space where the boiler or thermal oil heater is located will be specially considered. However, for cargoes with a flash point exceeding 61°C , when the temperature of the product will be at least 15°C below the flash point, the heating system may be used during cargo operations without special consideration.~~

Existing paragraph 7.4.13 *has been renumbered* 7.4.12.

■ *Section 8*
Cargo temperature control arrangements

8.2 Water spray system

8.2.4 The water spray nozzles are to be arranged such that that the deck area will be covered totally and for Type G and C tankers the releasing gases can be settled in a safe manner.

~~*8.2.4*~~ *8.2.5* For cargoes for which a water spray system is mandatory, *see* list of chemicals in ADNR/ADN, Table C, Column 9 (*see* 1.3.8).

CORRIGENDUM

■ *Section 9*
Inert gas systems

9.2 Type C tankers and Type ~~N-open~~ N-closed tankers

Part 5, Chapter 14
Requirements for Fusion Welding of Pressure Vessels and Piping

Effective date 1 July 2010

■ *Section 1*
General

1.1 Scope

1.1.2 Fusion welded pressure vessels will be accepted only if manufactured by firms equipped and competent to undertake the quality of welding required for the Class of vessel proposed. For independent tanks intended for Type G tankers the Manufacturer's works are to be assessed and approved in accordance with the requirements specified in *Materials and Qualification Procedures for Ships*, Book A Procedure MQPS 0-4.

~~*1.1.3* The term 'fusion weld', for the purpose of these requirements, is applicable to welded joints made by manual, semi-automatic or automatic electric arc welding processes. Special consideration will be given to the proposed use of other fusion welding processes, *see* Section 6 for oxy-acetylene welding of pipes.~~

~~*1.1.4*~~ *1.1.3* For pressure vessels which only have circumferential seams, *see* Ch 9,1.5.5.

~~*1.1.5*~~ *1.1.4* Requirements for fusion welding of pressure vessels and piping of other recognized Codes or standards, giving an equivalent level of quality, can be accepted.

1.2 General requirements for welding plant and welding quality

1.2.1 In the first instance, and before work is commenced, the Surveyors are to be satisfied that the required quality of welding is attainable with the proposed welding plant, equipment and procedures reference is made to the *Materials and Qualification Procedures for Ships*, Book A, Procedure 0-4.

~~*1.2.2* The procedures are to include the regular systematic supervision of all welding, and the welders are to be subjected by the works' supervisors to periodic tests for quality of workmanship. Records of these tests are to be kept and are to be available for inspection by the Surveyors.~~

~~*1.2.3*~~ *1.2.2* All welding is to be ~~to the satisfaction of the Surveyors~~ in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

1.3 Manufacture and workmanship of fusion welded pressure vessels

1.3.1 Pressure vessels are to be constructed and examined in accordance with the requirements specified in Chapter 13 of the Rules for Materials, unless more stringent requirements are specified.

■ *Section 2*
Manufacture and workmanship of fusion welded pressure vessels

2.2 Materials of construction

~~*2.2.1* Materials used in welded construction are to be readily weldable and shall have proven weldability.~~

~~*2.2.2* Materials are to be supplied by firms that have been approved in accordance with the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as Rules for Materials).~~

~~*2.2.3* Where the construction details are such that materials are subject to through thickness strains, consideration should be given to using materials with specified through thickness properties as specified in Ch 3,8 of the Rules for Materials.~~

~~2.2.4~~ *2.2.1* Where the construction requires post-weld heat treatment, consideration should be given to certifying the material after subjecting the test pieces to a simulated heat treatment.

~~2.2.5 The identity of materials is to be established by way of markings, etc., so that traceability to the original manufacturer's certificate is maintained.~~

~~2.3 Cutting of materials~~

2.3.1 Materials may be cut to the required dimensions by thermal means, shearing or machining in accordance with the manufacturing drawings or specifications.

2.3.2 Cold shearing should not be used on materials in excess of 25 mm thick and, where used, the cut edges are to be cut back by machining or grinding for a minimum distance of 3 mm.

2.3.3 Material which has been thermally cut, is to be machined or ground back to remove all oxides, scale and notches.

2.3.4 Thermal cutting of alloy and high carbon steels may require the application of preheat, and special examination of these cut edges will be required to ensure freedom from cracking. In these cases the cut edges are to be machined or ground back a distance of at least 2 mm, unless it has been demonstrated that the cutting process has not damaged the material.

2.3.5 Any material damaged in the process of cutting is to be removed by machining, grinding or chipping back to sound metal; weld repair may only be performed with the agreement of the Surveyors.

2.3.6 All plate edges, after being cut, shall be examined for defects, including laminations, to ensure that these are free from cracks. Visual methods may be augmented by other techniques at the discretion of the Surveyors.

2.3.7 Edges that have been cut by machining or chipping, which will not be subsequently covered by weld metal, are to be ground smooth.

2.4 Forming shell sections and end plates

2.4.1 Shell plates and heads are to be formed to the correct contour up to the extreme edge of the plate.

2.4.2 Plates may be formed to the required shape either hot or cold and by any process that does not impair the quality of the material. Tests to demonstrate the suitability of the forming process may be requested at the discretion of the Surveyors.

2.4.3 Wherever possible, forming is to be performed by the application of steady continuous loading using a machine designed for that purpose. The use of hammering, in either ~~the hot or cold condition should not be employed.~~

~~2.4.4 Material may be welded prior to forming or bending,~~ provided that it can be demonstrated that the mechanical properties of the welds are not impaired by the forming operation. All welds subjected to bending are to be inspected on completion to ensure freedom from surface breaking defects.

2.4.5 Vessels manufactured from carbon or carbon manganese steel plates which have been hot formed or locally heated for forming are to be re-heat treated in accordance with the original supplied condition on completion of this operation. Vessels formed from plates supplied in the as-rolled condition shall be heat treated in accordance with the material manufacturer's recommendations.

2.4.6 Where these steels are supplied in the as-rolled, normalized or normalized rolled condition, if hot forming is carried out entirely at a temperature within the normalizing range, subsequent heat treatment will not be required.

2.4.7 For alloy steel vessels, where hot forming is employed, the plates are to be heat treated on completion in accordance with the material manufacturer’s recommendations.

2.4.8 Where plates are cold formed, subsequent heat treatment is to be performed where the internal radius is less than 10 times the plate thickness. For carbon and carbon-manganese steels, this heat treatment may be a stress relief heat treatment.

2.4.9 In all cases where hot forming is employed, and for cold forming to an internal radius less than 10 times the thickness, the manufacturer is required to demonstrate that the forming process and subsequent heat treatments result in acceptable properties.

2.5 Fitting of shell plates and attachments

2.5.1 Careful consideration is to be given to the assembly sequence to be employed, in order to minimize overall shrinkage and distortion and to reduce the build up of residual stresses.

2.5.2 Excessive force is not to be used in fairing and closing the work. Where excessive root gaps exist between surfaces or edges to be joined, the corrective measures adopted are to be to the satisfaction of the Surveyors.

2.5.3 Provision is to be made for retaining correct alignment during welding operations.

2.5.4 In all cases, where tack welds are used to retain plates or parts in position prior to welding, they are to be made using approved welding procedures.

2.5.5 Where temporary bridge pieces or strong-backs are used, they are to be of similar materials to the base materials and are to be welded in accordance with approved welding procedures.

2.5.6 Where welding to clad materials, any fit-up aids and tack welds are to be attached to the base materials and not to ~~the cladding.~~

2.5.7 The location of welded joints are to be such as to avoid intersecting butt welds in the vessel shell plates. The attachment of nozzles and openings in the vessels are to be arranged to avoid main shell weld seams.

2.5.8 The surfaces of the plates at the longitudinal or circumferential seams are not to be out of alignment with each other, at any point, by more than 10 per cent of the plate thickness. In no case is the mis-alignment to exceed 3 mm for longitudinal seams, or 4 mm for circumferential seams.

2.5.9 Where a vessel is constructed of plates of different thicknesses (tube plate and wrapper plate), the plates are to be so arranged that their centrelines form a continuous circle.

2.5.10 For longitudinal seams, the thicker plate is to be equally chamfered inside and outside by machining over a circumferential distance not less than twice the difference in thickness, so that the plates are of equal thickness at the longitudinal weld seam. For the circumferential seam, the thickest plate is to be similarly prepared over the same distance longitudinally.

2.5.11 For the circumferential seam, where the difference in the thickness is the same throughout the circumference, the thicker plate is to be reduced in thickness by machining to a taper for a distance not less than four times the offset, so that the two plates are of equal thickness at the weld joint. A parallel portion may be provided between the end of the taper and the weld edge preparation; alternatively, if so desired, the width of the weld may be included as part of the smooth taper to the thicker plate.

2.6 Welding during construction

2.6.1 Welding plant and equipment is to be suitable for the purpose intended and properly maintained, taking due cognisance of relevant safety precautions. Electrical meters are to be properly maintained and have current calibrations.

2.6.2 Welding consumables are to be suitable for the type of joint and grade of material to be welded and satisfactory storage and handling facilities are to be provided close to working areas.

2.6.3 Prior to use, welding consumables should be dried and/or baked in accordance with the consumable manufacturer's recommendations. The condition of welding consumables shall be subject to regular inspections.

2.6.4 All welders and welding operators are to be suitably skilled and qualified for the type of welding work to be undertaken.

2.6.5 Welding procedures are to be established for all welds joining pressure containing parts and for welds made directly onto pressure containing parts.

2.6.6 Welding should be performed wherever possible in covered workshops. Where this is not possible, provision is to be made in the welding area to give adequate protection from wind, rain and cold, etc.

2.6.7 Surfaces of all parts to be welded are to be clean, dry and free from rust, scale and grease. Where prefabrication primers are applied over areas which will be subsequently welded, they are to be approved for that application.

2.6.8 Preheat shall be applied, as specified in the approved welding procedure, for a distance of at least 75 mm from the joint preparation edges. The method of application and temperature control are to be such as to maintain the required level during welding and is to be to the satisfaction of the Surveyors.

2.6.9 When the ambient temperature is 0°C or less, or where moisture resides on the surfaces to be welded, due care should be taken to pre-warm and dry the weld joint.

2.6.10 The welding arc is to be struck on the parent metal which forms part of the weld joint or on previously deposited weld metal.

2.6.11 Tack welds made in the root of the weld joint are to be removed in the process of welding the seam.

2.6.12 Where the welding process used is slag forming (e.g. manual metal arc, submerged arc, etc.) each run of deposit is to be cleaned and free from slag before the next run is applied.

2.6.13 Wherever possible, full penetration welds are to be made from both sides of the joint. Prior to welding the second side, the weld root is to be cleaned, in accordance with the requirements of the approved welding procedure, to ensure freedom from defects. When air-arc gouging is used, care is to be taken to ensure that the ensuing groove is slag and oxide free and has a profile suitable for welding.

2.6.14 After welding has been stopped for any reason, care is to be taken in restarting to ensure that the previously deposited weld metal is thoroughly cleaned of slag and debris, and preheat has been re-established.

2.6.15 Where welding from one side only cannot be avoided, care is to be exercised to ensure the root gap is in accordance with the approved welding procedure and the root is properly fused.

2.6.16 Steel backing strips may be used for the circumferential seams of Class 2/1, Class 2/2 and Class 3 pressure vessels and are to be the same nominal composition as the plates to be welded.

2.6.17 Fillet welds are to be made to ensure proper fusion and penetration at the root of the fillet. At least two layers of weld metal are to be deposited at each weld affixing branch pipes, flanges and seatings.

2.6.18 Where attachment of lugs, brackets, branches, manhole frames, reinforcement plates and other members are to be made to the main pressure shell by welding, these shall be to the same standard as that required for the main vessel shell construction.

2.6.19 The attachment by welding of such fittings to the main pressure shell after post-weld heat treatment is not permitted.

~~2.6.20 Completed welds shall be at least flush with the~~ surface of the plates joined and have the shape and size specified in the approved drawings or specifications. Welds shall have an even contour and blend smoothly with the base materials. Maximum sizes of weld reinforcement in accordance with a recognized Pressure Vessel Code or Standard will be accepted.

2.6.21 The main weld seams and all welded attachments made to pressure containing parts are to be completed prior to post weld heat treatment. Tubes that have been expanded into headers or drums may be seal welded without further post weld heat treatment.

2.6.22 The finish of welds attaching pressure parts and non-pressure parts to the main pressure shell is to be such as to allow satisfactory examination of the welds. In the case of Class 1 and Class 2/1 pressure vessels, these welds are to be ground smooth, if necessary, to provide a suitable finish for examination.

2.6.23 All lugs, brackets, branches, manhole frames and reinforcements around openings and other members are to conform to the shape of the surface to which they are ~~attached.~~

~~2.7~~ 2.3 Tolerances for cylindrical shells

Existing paragraphs 2.7.1 *to* 2.7.6 *have been renumbered* 2.3.1 *to* 2.3.6.

~~Section 3~~ Routine weld tests for pressure vessels

3.1 General requirements for routine weld tests

3.1.1 Routine or production weld tests are specified as a means of monitoring the quality of the welded joints and are required for pressure vessel Classes 1, 2/1 and 2/2.

3.1.2 Routine test plates are required during the manufacture of vessels and as part of the initial approval test programme for Class 1 vessel manufacturers, refer to MQPS 0-4.

3.1.3 Routine weld tests are not required for Class 3 pressure vessels unless the minimum design temperature is below minus 10°C. However, occasional check tests may be requested at the discretion of the Surveyors.

3.1.4 Routine test plates are not required for circumferential seams of cylindrical pressure vessels. Spherical vessels are to have one test plate prepared having a welded joint which is a simulation of the circumferential seams.

3.1.5 In addition, routine weld tests may be requested by the Surveyor where there is reason to doubt the quality of workmanship.

~~3.2~~ Test plate requirements

3.2.1 Test plates, of sufficient dimensions to provide one complete set of specimens, are to be prepared for each vessel and are to be welded as a continuation and simulation of the longitudinal weld joint.

3.2.2 For Class 2/2 vessels, where a large number are made concurrently at the same works using the same welding procedure and the plate thicknesses do not vary by more than 5 mm, one test may be performed for each 37 m of longitudinal plus circumferential weld seam with the agreement of the Surveyor. In these cases, the thickness of the test plate is to be equal to the thickest shell plate used in the construction.

3.2.3 Where the vessel size or design results in a small number of longitudinal weld seams, with the agreement of the Surveyors, one test plate may be prepared for testing, provided that the welding details are the same for each seam.

3.2.4 Test plate materials shall be of the same grade, thickness and supply condition and from the same cast as that of the vessel shell. The test plate shall be welded at the same time as the vessel weld to which it relates and is to be supported so that distortion during welding is minimized.

3.2.5 Where there is a requirement for several routine tests to be welded, welding is to be performed by different welders, wherever possible.

3.2.6 The test assembly may be detached from the vessel weld only after the Surveyor has performed a visual examination and has added his mark or stamp. Straightening of test weld prior to mechanical testing is not permitted.

3.2.7 Where the pressure vessel is required to be subjected to post-weld heat treatment, the test weld shall be heat treated, after welding, in accordance with the same requirements. Subject to agreement with the Surveyor this may be performed separately from the vessel.

3.3 Inspection and testing

3.3.1 The test weld is to be subjected to the type of non-destructive examination and acceptance criteria as specified for the weld seam to which the test relates. Non-destructive examination shall be performed prior to removing specimens for mechanical testing, but after any post-weld heat treatment.

3.3.2 The test weld is to be sectioned to remove the number and type of test specimens for mechanical testing as ~~follows.~~

3.4 Mechanical testing requirements

3.4.1 The test plates are to be machined to provide the following test specimens:

(a) Tensile.
(b) Bend.
(c) Hardness.
(d) Impact, *see* Table 14.3.1.
(e) Macrograph and hardness survey of full weld section.

Table 14.3.1 Impact test requirements

Pressure vessel Class	Minimum design temperature	Plate material thickness, *t,* in mm	Impact test temperature
Class 1	–10°C or above	All	5°C below the minimum design temperature or 20°C whichever is the lower
All Classes	Below –10°C	$t \leq 20$	5°C below the minimum design temperature
		$20 < t \leq 40$	10°C below the minimum design temperature
		$t > 40$	Subject to agreement

3.4.2 One set of specimens for mechanical testing is to be removed, as shown in Fig. 14.3.1 or Fig. 14.3.2, as appropriate for the Class of approval. Impact tests shall be removed and tested where required by Table 14.3.1.

3.4.3 **Longitudinal tensile test for weld metal**. An all weld metal longitudinal tensile test is required and, for thicknesses in excess of 20 mm where more than one welding process or type of consumable has been used to complete the joint, additional longitudinal tests are required from the respective area of the weld. This does not apply to thse welding process or consumables used solely to deposit the root weld. Specimens shall be tested in accordance with the following requirements:

(a) The diameter and gauge length of the test specimen shall be in accordance with Fig. 11.2.1 in Chapter 11 of the Rules for Materials.
(b) For carbon steels, the tensile strength of the weld metal is to be not less than the minimum specified for the plate material and not more than 145 N/mm^2 above this value. The percentage elongation, A, is to be not less than that given by:

$$A = \frac{(980 - R)}{21{,}6}$$

where

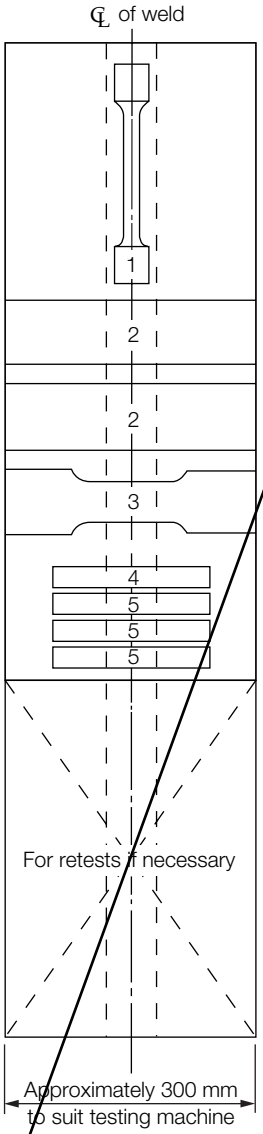

Fig. 14.3.1
Routine test plate – Test specimens for Class 1 and 2/1

1. All weld metal tensile test specimen.
2. Bend test specimens.
3. Tensile test for joints.
4. Macro-test specimen.
5. Charpy V-notch impact test specimens.
   (For all Class 1 pressure vessels and other Classes of pressure vessels where the minimum design temperature is below –10°C).

R is the tensile strength, in N/mm^2, obtained from the all weld metal tensile test.

In addition, this elongation is to be not less than 80 per cent of the minimum elongation specified for the plate.

(c) For other materials, the tensile strength and percentage elongation shall not be less than that specified for the base materials welded.

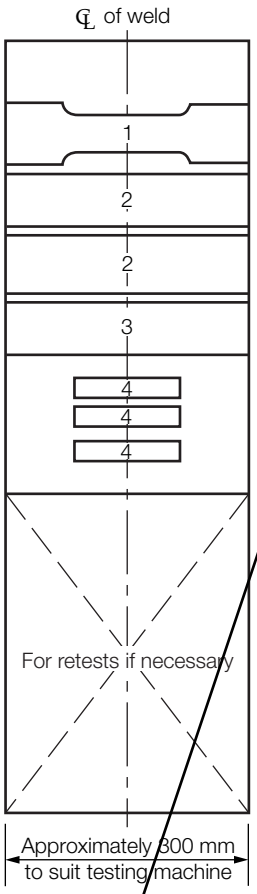

Fig. 14.3.2
Routine test plate – Test specimens for Class 2/2

1. Tensile test for joints.
2. Bend test specimens.
3. Macro-test specimen.
4. Charpy V-notch impact test specimens (if required by Table 14.3.1).

3.4.4 **Transverse tensile test for joint**. For the transverse tensile test, the weld reinforcement is to be removed, and shall meet the following requirements:

(a) One reduced section tensile test specimen is to be cut transversely to the weld in accordance with the dimensions shown in Fig. 11.2.2 in Chapter 11 of the Rules for Materials.

(b) In general, where the plate thickness exceeds 30 mm, or where the capacity of the tensile test machine prevents full thickness tests, each tensile test may be made up of several reduced section specimens, provided that the whole thickness of the weld is subjected to testing.

(c) The tensile strength obtained is to be not less than the minimum specified tensile strength for the plate material, and the location of the fracture is to be reported.

3.4.5 **Transverse bend test**. The bend test specimens shall meet the following:

(a) Four bend test specimens of rectangular section are to be cut from the test plate transversely to the weld, two bent with the outer surface of the weld in tension (face bend), and the other two with the inner surface in tension (root bend).

Table 14.3.2 Bend test requirements

Material grade	Former diameter
Up to Grade 460	3*t*
490 and 510	4*t*
13Cr Mo 45	5*t*
11Cr Mo 910	5*t*
Other materials	Subject to agreement

where
t is the thickness of the bend test specimen.

(b) The specimens are to be in accordance with Ch 11,2.1.3 of the Rules for Materials.

(c) Each specimen is to be mounted on roller supports with the centre of the weld midway between the supports. The plunger shall have the diameter shown in Table 14.3.2 based on the specimen thickness, *t*.

(d) After bending through an angle of at least 120°, there is to be no crack or defect exceeding 1,5 mm measured across the specimen or 3 mm measured along the specimen. Premature failure at the edges of the specimen should not be cause for rejection, unless this is associated with a weld defect.

3.4.6 **Macro-specimen and hardness survey**. A macro examination specimen is to be removed from the test plate near the end where welding started. The specimen is to include the complete cross-section of the weld and the heat affected zone. The specimen is to be prepared and examined in accordance with the following:

(a) The cross-section of the specimen is to be ground, polished and etched to clearly reveal the weld runs, and the heat affected zones.

(b) The specimen shall show an even weld profile that blends smoothly with the base material and have satisfactory penetration and fusion, and an absence of significant inclusions or other defects.

(c) Should there be any doubt as to the condition of the weld as shown by macro-etching, the area concerned is to be microscopically examined.

(d) For carbon, carbon manganese and low alloy steels, a hardness survey is to be performed on the macro specimen using either a 5 kg or 10 kg load, testing is to include the base material, the weld and the heat affected zone. Hardness scans on the cross-section are to be performed in the cap weld areas within 2 mm of the weld surface. The maximum recorded hardness shall not exceed 350 Hv10.

3.4.7 **Charpy V-notch impact test**. Charpy V-notch impact test specimens are to be prepared for testing when required by Table 14.3.1. Tests are to be performed and satisfy the following requirements:

(a) Each test is to consist of a set of three Charpy V-notch impact specimens and are to be removed with the vee notch perpendicular to the plate surface.

(b) The dimensions and tolerances of the specimens are to be in accordance with Chapter 2 of the Rules for Materials.

(c) Specimens are to be removed for testing from the weld centreline and the heat affected zone (fusion line and fusion line + 2 mm locations). Heat affected zone impact tests may be omitted where the minimum design temperature is above +20°C.

(d) For thicknesses in excess of 20 mm, where more than one welding process or type of consumable has been used to complete the joint, impact tests are required from the respective area of the weld. This does not apply to the welding process or consumables used solely to deposit the root weld.

(e) The average energy of a set of three specimens is not to be less than 27Joules or the minimum specified for the base material, whichever is the higher. The minimum energy for each individual specimen is to meet the requirements of Ch 1,4.5.2 of the Rules for Materials.

3.5 Failure to meet requirements

3.5.1 If any test specimen fails to meet the requirements, additional specimens may be removed and tested in accordance with Ch 1,4.6 of the Rules for Materials.

3.5.2 Where a routine weld test fails to meet requirements, the welds to which it relates will be considered as not having met the requirements. The reason for the failure is to be established and the manufacturer is to take such steps as necessary to either:

(a) Remove the affected welds and have them re-welded to the Surveyor's satisfaction, or

(b) demonstrate that the affected production welds have acceptable properties.

■ *Section 4 3* Repairs to welds on fusion welded pressure vessels

4.1 3.1 General

4.1.1 3.1.1 Where non-destructive examinations reveal un-acceptable defects in the welded seams, they are to be repaired in accordance with the following: Repair to welds on fusion welded pressure vessels are to be in accordance with the requirements of Chapter 13 of the Rules for Materials.

(a) Major repairs shall not be carried out without the prior consent of the Surveyors.

(b) Where cracks have developed as a result of welding, these are to be reported to the Surveyors and the cause established prior to undertaking weld repair.

(c) Defects may be removed by grinding, chipping or thermal gouging. Where thermal gouging is used, the repair groove shall be subsequently ground to remove oxides and debris. In all cases, the groove shall have a profile suitable for welding.

(d) Prior to commencing repair welding, confirmation that the original defect has been removed is required by performing visual examination. This may be augmented by surface crack detection examination at the discretion of the Surveyors.

(e) Repair welding is to be performed using welding procedures agreed with the Surveyors.

(f) Where the pressure vessel requires post weld heat treatment in accordance with Section 5, this shall be performed after completion of the weld repairs.

(g) Weld repairs are to be shown by further non-destructive examinations to have removed the defect to the Surveyor's satisfaction.

4.2 Re-repairs

4.2.1 In general, only two repair attempts are to be made of the same defect. Any subsequent repairs will be at the discretion of the Surveyors and may require the removal of the heat affected zone of the original repair.

■ *Section 5 4* Post-weld heat treatment of pressure vessels

5.1 4.1 General

5.1.1 4.1.1 Fusion welded pressure vessels, where indicated in Table 14.5.1, are to be heat treated on completion of the welding of the seams and of all attachments to the shell and ends, and before the hydraulic test is carried out. Post-welded heat treatment of fusion welded pressure vessels are to be in accordance with the requirements of Chapter 13 of the Rules for Materials.

5.1.2 Tubes which have been expanded into headers or drums may be seal welded without further post weld heat treatment.

5.1.3 Where the weld connects parts of different thicknesses, the thickness to be used when applying the requirements for post weld heat treatment is to be either the thinner of the two plates for butt welded connections, or the thickness of the shell for connections to flanges, tubeplates and similar connections.

5.1.4 Parts are to be properly prepared for heat treatment, sufficient temporary supports are to be provided to prevent undue distortion or collapse of the structure and any machined faces are to be adequately protected against scaling.

5.1.5 Care is to be exercised to provide drilled holes in double reinforcing plates and other closed spaces prior to heat treatment.

5.2 Basic requirements for heat treatment of fusion welded pressure vessels

5.2.1 Heat treatment is to be carried out in a properly constructed furnace which is efficiently maintained.

5.2.2 The heat treatment facilities shall be capable of controlling the temperature throughout the heat treatment cycle and adequate means of measuring and recording the vessel temperature are to be provided. To this end, thermo-couples are to be attached such that they are in contact with the vessel.

~~Table 14.5.1~~ ~~Post-weld heat treatment requirements~~

Type of steel	Plate thickness above which post weld heat treatment (PWHT) is required	
	Steam raising plant	Other pressure vessels
Carbon and carbon/manganese steels without low temperature impact values	20 mm	30 mm
Carbon and carbon/manganese steels with low temperature impact values	20 mm	40 mm
1Cr $^1/_2$Mo	All thicknesses	All thicknesses
$2^1/_4$Cr 1Mo	All thicknesses	All thicknesses
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	All thicknesses	All thicknesses
Other alloy steels	Subject to special consideration.	

5.2.3 Unless stated otherwise, post weld heat treatment is to be carried out by means of slow, even heating from 300°C to the soak temperature, holding within the prescribed soaking temperature range for the time specified (usually one hour per 25 mm of weld thickness), followed by slow even cooling to 300°C.

5.2.4 Recommended soaking temperatures and periods are given in Table 14.5.2 for different materials. Where other materials are used for pressure vessel construction, full details of the proposed heat treatment are to be submitted for consideration.

5.2.5 Where pressure vessels are of such dimensions that the whole length cannot be accommodated in the furnace at one time, the pressure vessels may be heated in sections, provided that sufficient overlap is allowed to ensure the heat treatment of the entire length of the longitudinal seam.

5.2.6 Where it is proposed to adopt special methods of heat treatment, full particulars are to be submitted for consideration. In such cases it may be necessary to carry out tests to show the effect of the proposed heat treatment.

~~Table 14.5.2~~ ~~Post-weld soak temperatures and times~~

Material type	Soak temperature, °C (*see* Note)	Soak period
Carbon and carbon/manganese grades:	580–620°	1 hour per 25 mm of thickness, minimum of 1 hour
1Cr $^1/_2$Mo	620–660°	1 hour per 25 mm of thickness, minimum of 1 hour
$2^1/_4$Cr 1Mo	650–690°	1 hour per 25mm of thickness, minimum of 1 hour
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	670–720°	1 hour per 25mm of thickness, minimum of 1 hour

NOTE
For materials supplied in the tempered condition, the post weld soak temperature shall be lower than the material tempering temperature.

■ *Section ~~6~~ 5* Welded pressure pipes

~~6.1~~ 5.1 General

~~6.1.1~~ 5.1.1 ~~Fabrication of pipework is to be carried out in accordance with the requirements of this Section unless other more stringent requirements have been specified.~~ Fabrication of pipework is to be carried out in accordance with the requirements of Ch 13,5 of the Rules for Materials.

~~6.1.2~~ ~~Piping systems are to be constructed in accor~~dance with approved plans and specifications.

6.1.3 Pipe welding may be performed using manual, semi-automatic or fully-automatic electric arc welding processes. The use of oxy-acetylene welding will be limited to Class III pipework in carbon steel material that is not carrying flammable fluids and limited to butt joints in pipes not exceeding 100 mm diameter or 9,5 mm wall thickness.

6.2 Fit-up and alignment

6.2.1 Acceptable methods of flange attachment are illustrated in Fig. 10.2.1 in Chapter 10. If backing rings are used with flange type (a) then they are to fit closely to the bore of the pipe and should be removed after welding. The rings are to be made of the same material as the pipes.

~~6.2.2~~ ~~Alignment of pipe butt welds shall be in accordance~~ with Table 14.6.1. Where fusible inserts are used, the alignment shall be within 0,5 mm in all cases.

Table 14.6.1 Pipe alignment tolerances

Pipe size	Maximum permitted mis-alignment
D < 150ϕ mm and $t \leq 6$ mm	1 mm or 25% of t, whichever is the lesser
D < 300ϕ mm and $t \leq 9,5$ mm	1,5 mm or 25% of t, whichever is the lesser
$D \geq 300$ and $t > 9,5$ mm	2 mm or 25% of t, whichever is the lesser
D =pipe internal diameter t =pipe wall thickness	

6.2.3 Where socket welded fittings are employed, they are to comply with the requirements of Ch 10,2.7. The diametrical clearance between the outside diameter of the pipe and the bore of the fitting is not to exceed 0,8 mm, and a gap of approximately 1,5 mm is to be provided between the ~~end of the pipe and the bottom of the socket.~~

~~6.3~~ 5.2 Welding workmanship

~~*6.3.1* Welding procedures are to be established for~~ welding of pipework including attachment welds directly to pressure retaining parts and are to be qualified by testing on simulated joints.

6.3.2 Where the work requires a significant number of branch connections, tests may also be required to demonstrate that the type of joint(s) and welding techniques employed are capable of achieving the required quality.

6.3.3 Welding consumables and, where used, fusible root inserts, are to be suitable for the materials being joined.

6.3.4 For welding of carbon and low alloy steels, preheat is to be applied depending on the material grade, thickness and hydrogen grading of the welding consumable in accordance with Table 14.6.2 unless welding procedure testing ~~indicates that higher levels are required.~~

~~*6.3.5*~~ *5.2.1* Preheating is to be effected by a method which ensures uniformity of temperature at the joint. The method of heating and the means adopted for temperature control are to be to the satisfaction of the Surveyors.

~~*6.3.6*~~ *5.2.2* All welding is to be performed in accordance with the approved welding procedures, *see* ~~6.3.1~~ 5.3.1, by welders who are qualified for the materials, joint types and welding processes employed.

~~*6.3.7*~~ *5.2.3* Welding without filler metal is generally not permitted for welding of duplex stainless steel materials.

~~Table 14.6.2 Minimum preheat requirements~~

Material grade	Thickness t, in mm (4)	Minimum preheat temperature (1), °C	
		Non-low H_2	Low H_2 (2)
Carbon and carbon/manganese grades: 320 and 360	$t \leq 10$ $t \geq 20$	50 100	10 50
Carbon and carbon/manganese grades: 410, 460 and 490	$t \leq 10$ $t \geq 20$	75 150	20 100
1Cr $^1/_2$Mo	t < 13 $t \geq 13$	(3)	100 150
2$^1/_4$Cr 1Mo	t < 13 $t \geq 13$	(3)	150 200
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	t < 13 $t \geq 13$	(3)	150 200

NOTES
1. For thicknesses up to 6 mm, the preheat levels specified may be reduced subject to satisfactory hardness testing during welding procedure qualification.
   In all cases where the ambient temperature is 0°C or below, preheat is required.
2. Low hydrogen process or consumables are those which have been tested and have achieved a grading of H15 or better, *see* Chapter 11 of the Rules for Materials.
3. Low hydrogen process is required for these materials.
4. t = the thickness of the thicker member.

~~*6.3.8*~~ *5.2.4* All welds in high pressure and high temperature pipelines are to have a smooth surface finish and even contour; if necessary, they are to be made smooth by grinding.

~~*6.3.9*~~ *5.2.5* Check tests of the quality of the welding are to be carried out periodically at the discretion of the Surveyors.

~~6.4 Heat treatment after bending of pipes~~

6.4.1 Heat treatment should be carried out in a suitable furnace provided with temperature recording equipment in accordance with 5.2.

6.4.2 Hot forming should generally be carried out within the normalizing temperature range. When carried out within this temperature range, no subsequent heat treatment is required for carbon and carbon/manganese steels. For alloy steels, 1Cr $^1/_2$Mo, 2$^1/_4$Cr 1Mo and $^1/_2$Cr $^1/_2$Mo $^1/_4$V, a subsequent stress relieving heat treatment in accordance with Table 14.5.2 is required irrespective of material thickness.

6.4.3 When hot forming is performed outside the normalizing temperature range, a subsequent heat treatment in ~~accordance with Table 14.6.3 is required.~~

~~Table 14.6.3 Heat treatment after forming of pipes~~

Type of steel	Heat treatment required
Carbon and carbon/manganese: Grades 320, 360, 410, 460 and 490	Normalize at 880 to 940°C
1Cr $^1/_2$Mo	Normalize at 900 to 960°C, followed by Tempering at 640 to 720°C
2$^1/_4$Cr 1Mo	Normalize at 900 to 960°C, followed by Tempering at 650 to 780°C
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	Normalize at 930 to 980°C, followed by Tempering at 670 to 720°C
Other alloy steels	Subject to special consideration

6.4.4 After cold forming to a radius measured at the centreline of the pipe of less than four times the outside diameter, heat treatment in accordance with Table 14.6.3 is required.

6.4.5 The heat treatments specified above shall be applied unless the pipe material manufacturer specifies or recommends other requirements.

6.4.6 Bending procedures and subsequent heat treatment for other alloy steels will be subject to special consideration.

6.5 Post-weld heat treatment of pipe welds

6.5.1 Post-weld heat treatment shall be carried out in accordance with the general requirements specified in 5.2 for pressure vessels.

6.5.2 Post-weld heat treatment is to be performed on steel pipes and fabricated branch pieces on completion of welding where the material thickness exceeds that specified in Table 14.6.4.

6.5.3 Recommended soaking temperatures and periods for post-weld heat treatment are given in Table 14.5.2.

6.5.4 Where oxy-acetylene welding has been used, due consideration should be given to the need for normalizing and tempering after such welding.

~~Table 14.6.4 Thickness limits for post-weld heat treatment of pipe welds~~

Type of steel	Requirements for heat treatment
Carbon and carbon/manganese: Grades 320, 360, 410, 460 and 490	Thicknesses exceeding 30 mm
1Cr $^1/_2$Mo	Thicknesses exceeding 8 mm
2$^1/_4$Cr 1Mo	All thicknesses
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	All thicknesses
Other alloy steels	Subject to special consideration

■ *Section ~~7~~ 6* Non-Destructive Examination

~~7.1~~ 6.1 General

~~7.1.1~~ 6.1.1 ~~Non-Destructive Examinations (NDE) of pressure vessel welds are to be carried out in accordance with a nationally recognized code or standard.~~ Non-Destructive Examination (NDE) of pressure vessels is to be performed in accordance with the requirements of the following Rules for Materials:

- Ch 13,1,1.11 General welding requirements.
- Ch 13,4, 4.12, 13, 14 and 15 Specific requirements for fusion welded pressure vessels.
- Ch 13,5,5.5 Specific requirements for pressure pipe work.

~~7.1.2~~ ~~NDE should not be applied until an interval of at~~ least 48 hours has elapsed since the completion of welding.

7.2 NDE personnel

7.2.1 NDE Personnel are to be qualified to an appropriate level of a nationally recognized certification scheme.

7.2.2 Generally, operators subject to direct supervision are to be qualified to Level I, unsupervised personnel to Level II and more senior personnel to Level III.

7.2.3 Qualification schemes are to include assessments of practical ability for Levels I and II individuals; these examinations to be made on representative test pieces containing relevant defects.

7.3 Extent of NDE

7.3.1 For Class 1 pressure vessels:

(a) All butt welded seams in drums, shells, headers and test plates, together with tubes or nozzles over 170 mm outside diameter are subject to 100 per cent volumetric and surface crack detection inspections.

(b) For circumferential butt welds in extruded connections, tubes, headers and other tubular parts of 170 mm outside diameter or less, at least 10 per cent of the total number of welds is to be subjected to volumetric examination and surface crack detection inspections.

7.3.2 For Class 2/1 pressure vessels, volumetric and surface crack detection inspections are to be applied at selected regions of each main seam. At least 10 per cent of each main seam is to be examined together with the full length of each welded test plate. When an unacceptable indication is detected, at least two additional check points in the seam are to be selected by the surveyor for examination using the same inspection method. If further unacceptable defects are found then either:

(a) The whole length of weld represented is to be cut out and re-welded and re-examined as if it was a new weld with the test plates being similarly treated; or
(b) The whole length of the weld represented is to re-examined using the same inspection methods.

7.3.3 Butt welds in Class I pipes of 75mm or more outside diameter are subject to 100 per cent volumetric and surface crack detection inspections. The extent and method of testing applied to butt welds in Class I pipes of less than 75 mm outside diameter is at the Surveyor's discretion.

7.3.4 The extent of testing to be applied to butt welds or fillet welds in Class II pipes of 100 mm or more outside diameter is at the Surveyor's discretion.

7.3.5 NDE is not required for Class II pipes less than 100 mm outside diameter.

7.4 Procedures

7.4.1 Non Destructive Examinations are to be made in accordance with a definitive written procedure prepared in accordance with a nationally recognized standard and endorsed by a Level III individual. As a minimum, the procedure will identify personnel qualification levels, NDE datum and identification system, extent of testing, methods to be applied with technique sheets, acceptance criteria and reporting requirements.

7.5 Method

7.5.1 Volumetric examinations may be made by radiography or, in the case of welds of nominal thickness 15 mm or above, by ultrasonic testing. The preferred method for surface crack detection in ferrous metals is magnetic particle inspection, and that for non-magnetic materials is liquid penetrant inspection.

7.6 Repairs

7.6.1 Unacceptable defects are to be repaired and re-examined using the NDE methods originally applied.

7.7 Evaluation and reports

7.7.1 The manufacturer shall be responsible for the review, interpretation, evaluation and acceptance of the results of NDE. Reports stating compliance or otherwise with the criteria established in the inspection procedure are to be issued. Reports are to include the following information where appropriate:

(a) Date of inspection;
(b) Names, qualifications and signatures of operator and supervisor;
(c) Component identification;
(d) Location and extent of testing;
(e) Heat treatment status;
(f) Weld type, procedure and configuration;
(g) Surface condition;
(h) Inspection procedure reference;
(j) Equipment used;
(k) Results showing size, position and nature of any defects repaired; and
(l) Statement of final acceptability to established criteria.

Part 5, Chapter 15

Steering Gear

CORRIGENDA

■ *Section 1* General

1.6 Rudder, rudder stock, tiller and quadrant

1.6.6 For conical sections, *S* is based on the following equation:

$$S = \frac{\mu A \sigma_r}{\sqrt{W + A \sigma_r \theta)^2 + Q^2}}$$

where

A = interfacial surface area, in mm^2

W = weight of rudder and stock, if applicable, when tending to separate the fit, in N

Q = shear force = $\frac{2M}{d_m}$ in N

where

d_m = in mm, is the mean contact diameter of tiller/stock interface and *M,* in N/mm, is defined in 1.6.5

~~Q~~ θ = cone taper half angle in radians (e.g. for cone taper 1:10, Q = 0,05)

~~m~~ μ = coefficient of friction

σ_r = radial interfacial pressure or grip stress, in N/mm^2.

Table 15.1.1 Connection of tiller to stock
~~(*conclusion*)~~ (*continuation*)

■ *Section 2* Performance

2.1 General

2.1.4 Where the main steering gear comprises two or more identical power units, an auxiliary steering gear need not be fitted, provided that:

(a) In a passenger ship, the main steering gear is capable of operating the rudder as required by 2.1.2~~(b)~~ (c) and (e) while any one of the power units is out of operation;

(b) In a cargo ship, the main steering gear is capable of operating the rudder as required by 2.1.2~~(b)~~ (c) and (e) while operating with all power units;

(c) The main steering gear is arranged so that after a single failure in its piping system or in one of the power units the defect can be isolated so that steering capability can be maintained or speedily regained.

Effective date 1 July 2010

■ *Section 3* Construction and design

3.4 Flexible hoses

3.4.2 Hoses for steering gear are to be replaced after 10 years of service or as per manufactured recommendations or as dictated by Surveyors.

Part 5, Chapter 16

Azimuth Thrusters

Effective date 1 July 2010

■ *Section 2* Performance

2.1 General

2.1.1 The arrangement of thrusters is to be such that the ship can be satisfactorily manoeuvred with both thrusters simultaneously as well as with a single thruster and is to be demonstrated during trials to an accepted trials programme.

CORRIGENDUM

■ *Section 3* Construction and design

3.2 Design

Table 16.3.1 Material factor (*Part only shown*)

NOTES

1. σ_o is to be taken not greater than 70 % of the ultimate tensile strength or 450 N/mm^2, whichever is the lesser.
2. For bolts, σ_o may be taken not greater than 70 ~~per cent% ehever is the lesser~~ per cent whichever is the lesser.

Part 5, Chapter 17
Steerable Bow Thrusters

Effective date 1 July 2010

■ *Section 1*
General requirements

1.1 Application

1.1.1 This Chapter applies to bow thruster units intended for manoeuvring having a power of 110 kW and over, fitted on ships with a length exceeding 110 m. *See* ~~*also*~~ Ch 1,5 or where a fire in the main machinery space could put the main propulsion engine(s) out of action. *See* Ch 1,4.3.4.

■ *Section 2*
Performance

2.1 General

2.1.1 The arrangement of the bow thruster is to be such that the ship can maintain a speed of not less than 7 km/h in the unloaded condition and can be satisfactorily ~~manoeuvred~~ propelled as per Ch 1,5. The steering gear of the bow thrust unit is to be provided with two independent means of steering in compliance with Ch 15,2.1.1 as far as applicable.

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Inland Waterways Ships.

Part 5, Chapter 10

8.2.2 *Reference* Ch 11,2.8 *has been renumbered* Ch 11,2.7.

4.2.1 *Reference* 4.2.4 *has been renumbered* 4.2.3.

Part 5, Chapter 12

11.2.7 *Reference* Ch 14,7 *has been renumbered* Ch 14,6.

Part 5, Chapter 13

1.4.2 *Reference* Ch 14,7 *has been renumbered* Ch 14,6.

1.5.1 *Reference* Pt 5, Ch 6,1.1 *has been renumbered* Pt 4, Ch 4,1.1.

4.3.4 *Reference* Section 4.5 *has been renumbered* 4.6.

Part 5, Chapter 14

2.1.7 *References* 3.4.4 and 3.4.5 *have been renumbered* the Rules for Materials Ch 13,4.8.4 and Ch 13,4.8.5.

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